SOME OBSERVATIONS ON THE HABITS OF THE SLENDER LORIS, *LORIS TARDIGRADUS* (LINNAEUS)

BY

(MRS.) SWARNA SUBRAMONIAM, M.SC.

(*With five plates*)

The anatomical aspects of *Loris tardigradus* have been subjected to an extended study by a series of workers. As one of the two living representatives of Lorisiformes of the Lemuroidea and a typical example of a tailless primate possessing such distinctive structural adaptations providing numerous striking morphological characters similar to the Anthropoidae and Hominidae and at the same time retaining some of the features of the primitive Mammalia, *Loris tardigradus* deserves a closer study regarding its habits.

Confined to the forest-clad misty ravines of the High Range in Travancore, Nilgiri Hills, and south-west Ceylon, its nocturnal, retiring, and arboreal habits, and its innocuousness to other fauna sharing the same environment make it difficult to observe in its natural habitat. The following is the result of an attempt to study the habits of eight specimens kept in captivity, with as much simulation as possible of the natural arboreal environment. They were reared in spacious deal-wood boxes with wire-netting fronts. Every morning, after cleaning the cages, fresh branches with foliage of jak, anjili, portia, mango, punna, or cashewnut trees were arranged inside the cages to provide natural arboreal surroundings. They were fed early morning and late in the evening. A shallow can filled with fresh water was provided every morning in each cage.

FOOD

A wide range of different food materials, both vegetable and animal, was given to the animal to study its likes, dislikes and preferences. Although omnivorous, it has been found to be predominantly insectivorous. The following were the food materials experimented with:

Vegetable Food: plantain, jak, mango, papaya, and rose-apple fruits, dates, currants; fried potato, plantain, and jak chips.

Animal Food: grasshoppers, mantis, crickets, cockroaches, termites, butterflies, moths, caterpillars, carabids, scarabids, stink bugs, dragon flies, damsel flies, lacewings, house fly, wasps, carpenter bees, rats, frogs, caridina, prawns, fish, earthworms, milk, and eggs.

Of the vegetable foods, plantain fruit was the only item which the animal ate, and that too only when the fruit was in an over-ripe condition. All the other items were summarily rejected.

Of the insects listed above every one was relished with the exception of stink bugs, butterflies, moths, hairy caterpillars, ant-lions, wasps, and carpenter bees, which were rejected. It was consistently observed that the loris ate only live insects. When dead insects were offered they were thrown away without hesitation.

Certain noteworthy characteristics were observed in the method of killing the insects and eating them. Whether the insect lay on the floor of the cage, or was placed on the branches, or was proffered in the cage at the end of a pair of forceps, the loris never picked it with its mouth. The insect is first of all caught by both its hands if the victim is a big one, or by the left hand if the insect is a small one—always and consistently by the left hand. Only on one occasion the loris was found using the right hand to catch an insect, and at that time the left hand was gripping a support. When an insect was securely caught in the hand, the anterior part of the victim was taken right into the mouth and the head was crushed between the molars, probably to put a stop to its struggle. Invariably on all occasions, the head of the insect was first of all bitten off and eaten. Then the entire body, wings, and the appendages were devoured. Two exceptions were noticed in its usual habit of consuming the entire insect. In the case of cockroaches, after munching the abdomen, which is the last portion consumed, the loris spits out the black alimentary canal. In another instance, when a Rhinoceros beetle (*Oryctes rhinoceros*) about 2″ long was the victim, the loris rejected the legs, the elytra, and the wings. It was noticed that the loris munched that part of the wings where they were attached to the thorax and threw away the membranous part. The legs and elytra were too chitinous and hard for the loris to chew. Curiously enough, this beetle although much bigger than a cockroach did not suffer the ignoble fate of the latter of having its alimentary canal jettisoned. With the exception of the legs, elytra, and wings the entire beetle was consumed. The intestines of the cockroach alone are found to be distasteful to the loris. The causes for this rejection are being investigated.

On one occasion a young rat (about three days old) happened to fall down from the ceiling of the house. The creature was obviously stunned by the fall and lay still, breathing and living. It was tendered into a cage containing four lorises. They attacked it with avidity, each one struggling to get a major portion, and within five minutes the entire rat was consumed. With a view to see whether the lorises are able to subdue an adult rat, one (about 3″ long) was caught in a trap next day and left in the cage. An hour later it was found that the posterior half (abdomen, legs, and tail) of the rat was left unconsumed.

The lorises ate live fish. The fish offered was *Aplocheilus* caught from the lake near-by living and struggling when introduced into the cage. It is strange that they relished the fish, a food material which obviously they are not accustomed to. Being arboreal animals catching such prey as they find on the trees they could not have come across any fish before.

Experiments with frogs and earthworms indicated that the lorises do not relish these creatures.

Liquid and semi-solid foods like milk and yolk of eggs were lapped up with the tongue. It drinks water sparingly from the can kept inside the cage. Water is lapped up with the tongue and, unlike the

Anthropoids, the loris does not drink water by suction through pouted lips.

To find out the maximum quantity of food it could consume at a time, each loris was fed with cockroaches on different dates. The average maximum was seen to be seven cockroaches.

While feeding, it was strange to notice that the first bite the loris gives to the head of the victim was by taking the anterior part of the insect far into the mouth between the molars, and not by the incisors. In spite of the fact that it has sharp incisors, the animal did by-pass them and took the insects on all occasions to the molars. Even when a piece of plantain fruit was given, the piece was caught by the hand and then pushed far into the mouth. The act of deliberately pushing the pieces in could be unmistakably seen. Is it because the incisors are not able to function, or are their bites ineffective? The following experiment was conducted to study them.

As usual, pieces of the plantain fruit were introduced into the cage stuck at the end of a slender wooden splinter. I wanted so to manage it that the loris bit the piece without taking hold of it in the hand. The branches, foliage, and perches kept inside the cage were removed. The loris had only a narrow platform, jutting out from the posterior side of the cage, to sit on. The wire-netting front was about nine inches from the platform. I introduced the fruit piece at the end of the wooden splinter high up through the wire-netting. The loris had to stand on its legs to reach it. The grip its legs maintained at the edge of the platform was not convenient to slant its body forward over nine inches. So it placed both its hands on the wire-netting for support. As it could not remove either of the hands it extended its neck and took the piece of fruit between its jaws. I noticed that the open mouth was being pushed forward, so that the fruit piece got between the molars on the right side before it closed its jaws and removed the piece from the splinter. This performance was satisfactory for the purpose of the investigation. When the next piece of fruit was about to be caught between the molars, I withdrew the splinter so that the bite fell between the incisors. The animal immediately opened its mouth again to get the piece further in and at this time I took away the splinter with the fruit piece for examination. The fruit piece was not severed and, as it was a soft over-ripe fruit, the impression of the incisors was not distinct; at any rate, the result of its bite on a soft ripe fruit gave sufficient indication that the bite of the incisors will be totally ineffective on the chitinous shell of an insect. To be abundantly cautious before arriving at such a conclusion, I wanted to examine the impression made by the incisors. I repeated the experiment with a piece of ripe but firm (not over-ripe) plantain fruit. But unfortunately the loris would not touch it.

Adaptability of the Limbs

The shoulder joint of the loris is endowed with almost universal movements of flexion, extension, abduction, adduction, and circumduction comparable to those of Anthropoidae and Hominidae, and more specialised than those of a generalised type of mammal. The hip joint permits the hind limb all the above mentioned movements to a greater range, much more than the Anthropoidae and Hominidae are capable of. There are few parts in the body which the toe cannot be made to explore, and the leg has its maximum mobility. It is remarkable to note the following wide range of mobility of the leg. In abduction, the thigh is capable of being raised outwards and upwards, so that the toes can touch the opposite shoulder across the back. In circumduction, by a combination of all movements it is capable of, the lower limb can move round a large circle, larger than could be possible for any of the Anthropoidae or Hominidae. The curious gait with which the animal moves on the ground and on the branches of trees, and the astonishing postures it is capable of assuming are evidently the result of the extraordinary powers of circumduction of its hind limbs. The legs although relatively slender seem to have been provided with powerful muscles. While grasping a vertical branch with the legs, the animal is seen capable of stretching its legs and body to their full length in almost a horizontal plane in order to get a grip on an adjoining branch. The animal is also able to maintain this posture for a long time.

The hand has a remarkable resemblance to that of man (fig. 1). The palm (fig. 2) is broader and flatter than the wrist and continuous with the front of the forearm, but its surface is raised from that of the forearm by the thenar and hypothenar prominences at the bases of the fingers. The opposable thumb is widely separated from the other digits. All the five digits have flattened nails, the distal ends of which come within 2 mm. of the extremities. The extraordinary mobility of the thumb distinguishes it from that of the Anthropoids. The thumb is well developed and its axis is directed downwards and outwards. The opposability of the thumb is influenced by its rotation, and an attempt was made to express this rotation by means of the angle between the transverse axis of the thumb and the transverse axis of the other digits. These axial lines were determined by a modification of the method adopted by Schultz (1) for a similar measurement in the gorilla. The fingers II to V were held straight and touching each other, and the thumb was abducted as much as possible. The axial lines were the median line passing through the third finger and that passing through the thumb. The angle between these lines was measured with a transparent protractor. The mean of the readings taken gave an angle of 120 degrees.

Schultz (1) records: 'Among the Simian primates the thumb is least rotated in Platyrrhines and most in the great apes. It is surprising to find that the thumb of man is, on an average, less rotated than are the thumbs of the Old World monkeys and apes. In the Chimpanzee the thumb rotation has reached the extreme, the relevant angle averaging less than 90 degrees.'

From the measurements taken of eight specimens under observation the thumb measured 12 mm.

The second digit is the shortest of the five and measured only 10 mm., giving a rudimentary appearance. Its nail is very small.

The third digit is 15 mm. long, the fourth digit, the longest in the hand, is 17 mm. long, and the fifth digit is 14 mm. long. The relative elongation of the fourth digit in the hand is a characteristic of the Loris, when in both Anthropoids and Hominids the third finger is the longest. Morton (2) has pointed out that such a disproportion in the digital formula may be related to the fact that, when the hand grasps a branch of a tree, a more secure hold is obtained if the palm is placed obliquely across it with the thumb opposed to and meeting the other digits round the branch and in this way increasing the span of the grasping hand.

When the hand is not employed either in catching hold of a branch or in walking, it is held up with the fingers clenched into a fist (fig. 7). The fingers close over the palm with the thumb below the second and third digits. It is also observed that, when the fingers are opened out or when around a branch in the act of gripping, the second digit which has a rudimentary appearance never straightens out, the distal phalange is always held slightly flexed inward (fig. 3).

The hind limb has a well developed hallux, very widely separated from the second digit, so widely abducted that it extends backwards. The hallux has all the mobility of the thumb and is opposable to the other digits of the foot but, however, not to such an extent as the pollex. The angle of abduction of the big toe is also 120 degrees. The big toe is 14 mm. long and has a small flattened nail.

The second toe is 10 mm. in length with a small pointed claw 5 mm. long. While all the other toes have small flattened nails, this second toe alone has a specialised sharp claw. Le Gros Clark (3) has pointed out its functional importance for grasping. Claws will undoubtedly increase the grip of the limb. But careful and continued observation does not confirm the statement that in *Loris tardigradus* the claw on the second toe helps the animal in grasping. It is found that the claw has very little part to play when the limb grasps a branch. It is seen that, when the hallux and the toes in opposite directions go round a branch, the second toe is so disposed that the claw lies over the third toe (fig. 8), its point does not touch the object within the grip, and unless the sharp point of the claw comes in contact with the branch it cannot serve any purpose in actually increasing the security of the grip. This peculiar disposition of the second toe cannot be considered as an abnormality in one loris since it has been observed in all the specimens examined.

Le Gros Clark (3) has suggested that this claw may be used by the animal for toilet purposes. Actually it was seen that the animal often used the second toe to scratch the body, and in doing so, since the toe is the shortest, the other toes close over the plantar surface so that the clawed toe stands out for the efficient use of the sharp appendage (fig. 12). In view of the fact that all the nails on the fingers and toes appear to be rudimentary and do not even extend to the tips of the digits, the animal uses the claws for scratching its body. Under the circumstances the sharp claws in the second toes are the only available appurtenances capable of penetrating the thick coating of fur for effective scratching.

The third toe is 13 mm. in length. The fourth toe, 15 mm. long, is the longest of the toes, and like the fourth finger shows a specialised functional adaptation for grasping. The fifth toe is 12 mm. long.

When the foot is raised from the ground or away from a branch the toes close in, but not to such an extent as the fingers of the hand.

The hallux and the toes bend towards each other leaving a gap between them.

The plantar pads are more prominent than those in the hand, more individual and often separated by grooves instead of lines. The thenar eminence is large and occupies almost half of the plantar surface, separated from the distal half by a deep groove starting from the centre of the inter-digital lobe between the hallux and the second toe and going up the hypothenar pad. On either side of the groove, the interdigital lobe thickens into two protruding processes. The faint lines and ridges, straight, concentric, and in loops, are seen on the plantar pads, having the same functional significance as those of the hand.

Morton (2) suggests that in Primates of more thoroughly arboreal types the foot is used to maintain to a greater or lesser degree a clinging or perching grasp of the branches, and that this has led to a specialisation and the wide abduction of the hallux, which can be opposed to the outer digits. The same holds good for the hands as well in the *Loris tardigradus*. All the postures and movements of the specimens I was able to observe made use of the predominant faculty of the limbs to have a firm grip. It was found difficult to dislodge the animal when once it had gained a grip on a branch.

The most characteristic pose is that it takes when at rest or sleeping. It rests or sleeps rolled up like a ball with the head and hands between the thighs. The legs take a firm grip round a branch with the lower portion of the torso resting between a fork formed of two branches or even on a horizontal limb of the tree. Sometimes the hands also catch the same branch which afforded a grip for the legs or another branch close by (figs. 15-18). The constant habit, as observed later, of the loris to frequent and remain on the outermost slender branches or twigs, surrounded by foliage, has presented the animal in the sleeping pose with their haunches not resting on bare naked branches. Before it settled down, it was seen pulling down one of the adjoining leaves and taking a seat with the leaf immediately below the haunches to relieve the discomfort of the hard bare surface of the branch. This possibly explains why *Loris tardigradus* has no ischial callosities often noticed in such arboreal animals as monkeys. Several variants of this posture have been observed and in all these the variations occur only in the disposition of the limbs in accordance with the availability of convenient branches nearby.

When, frightened, as for instance by bringing a dog in front of the cage, the loris stands erect on its legs with the arms drooping on either side of the chest, the hands clenched, and elbows held up at the level of the sternum (fig. 19). It remains steady and without the slightest movement in this posture stares continuously at the object it is afraid of or towards the direction from where a frightening sound is heard. But the attitude was different when a small pup was presented to it in front of the cage. It then stood up on its legs with clenched fists and half opened mouth, fixed a savage glare on the pup, and made repeated short starts as if about to spring forward, uttering at the same time audible guttural sounds.

The movements of the animal are slow and deliberate, and dependent on the grip of the limbs. It relies more on the grip of the

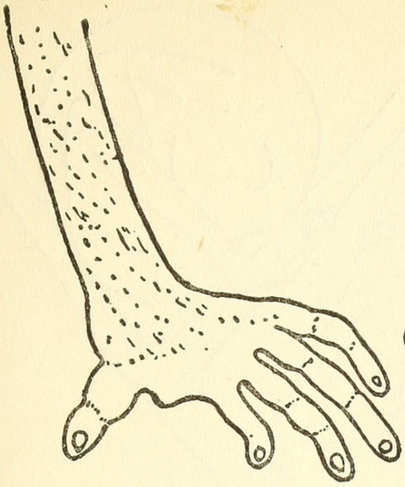
Fig. 1

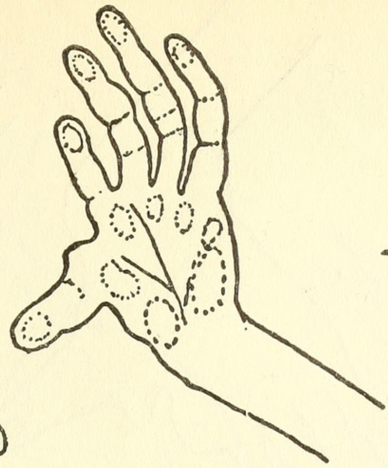
Fig. 2

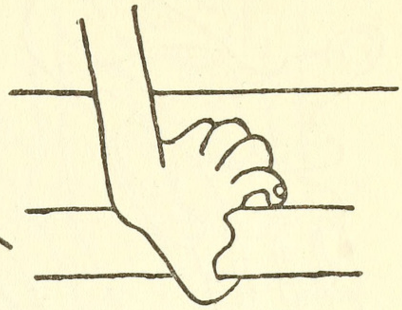
Fig. 3

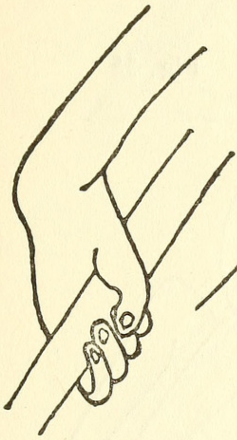
Fig. 4

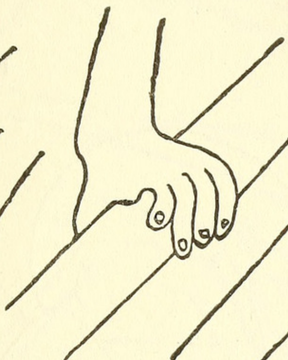
Fig. 5

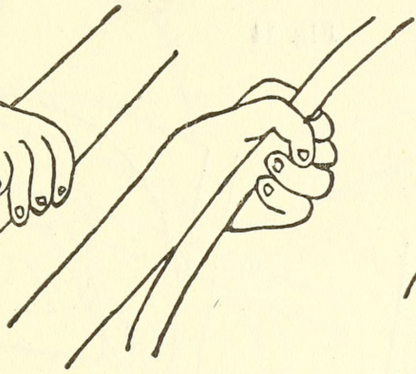
Fig. 6

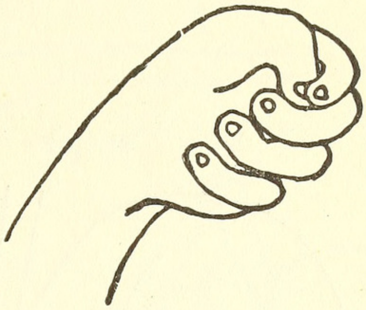
Fig. 7

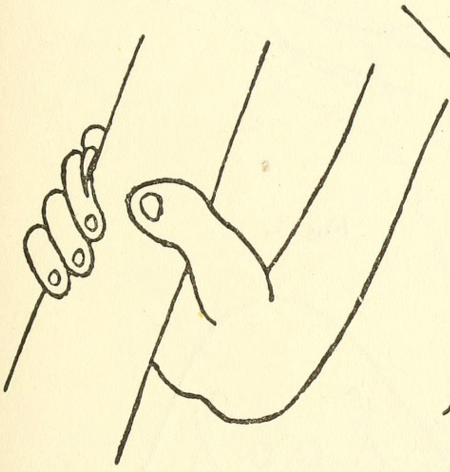
Fig. 8

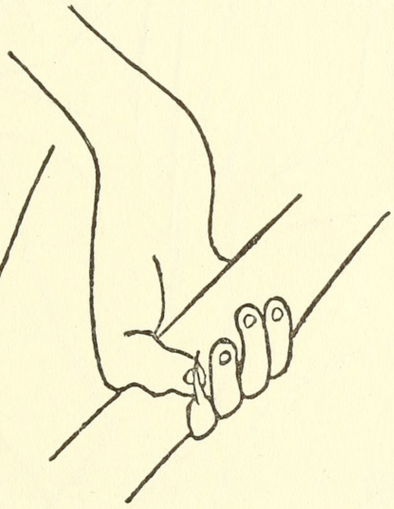
Fig. 9

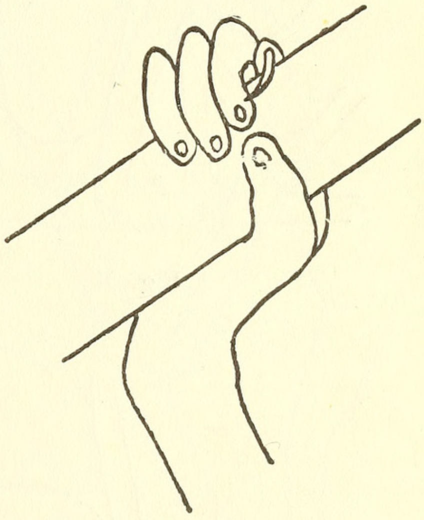
Fig. 10

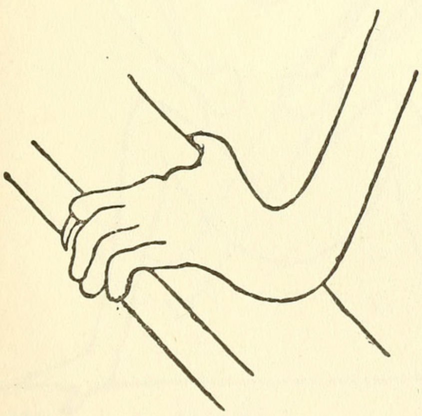
Fig. 11

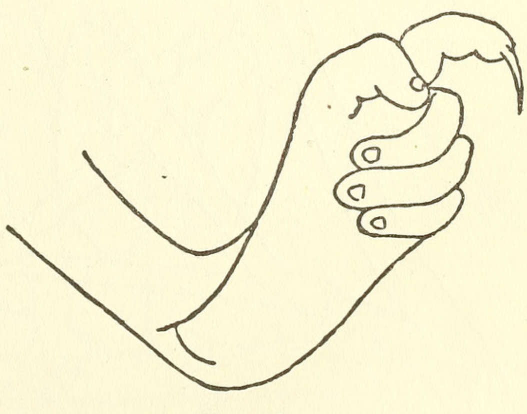
Fig. 12

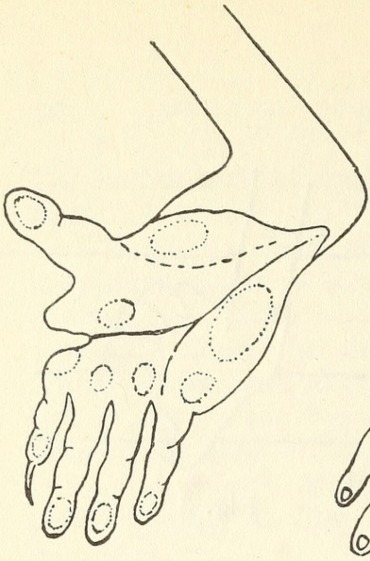

Fig. 13

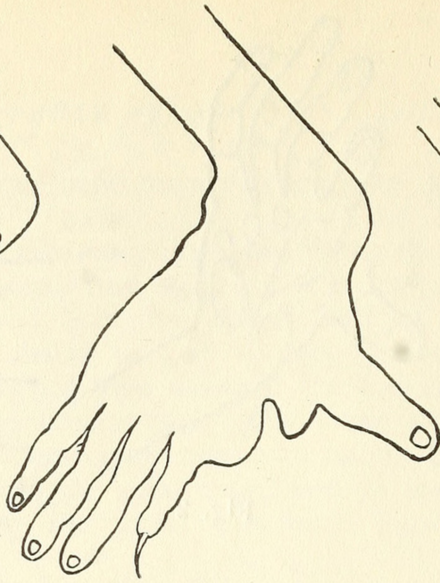

Fig. 14

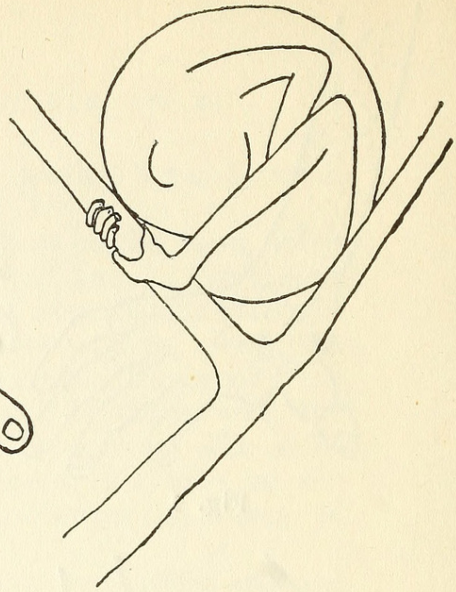

Fig. 15

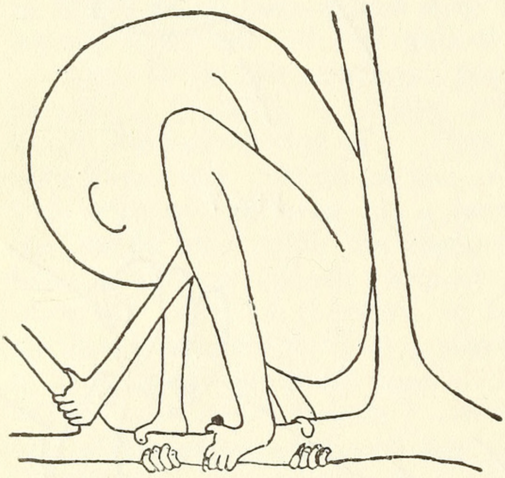

Fig. 16

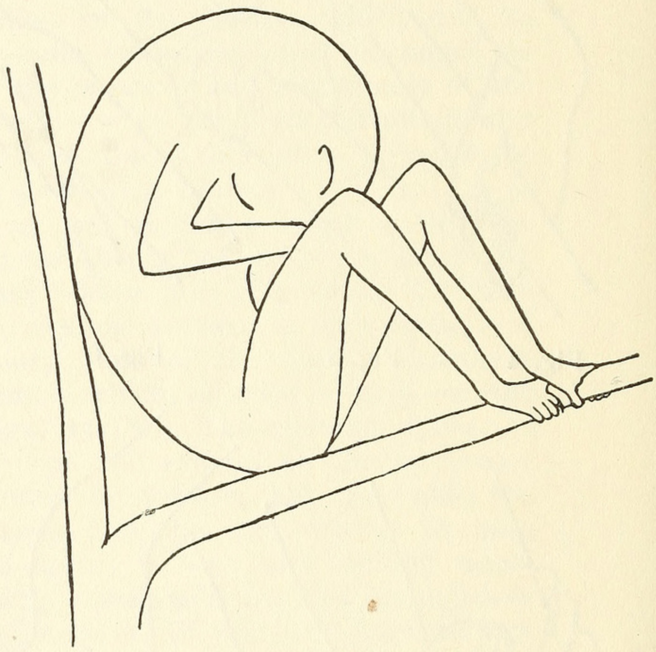

Fig. 17

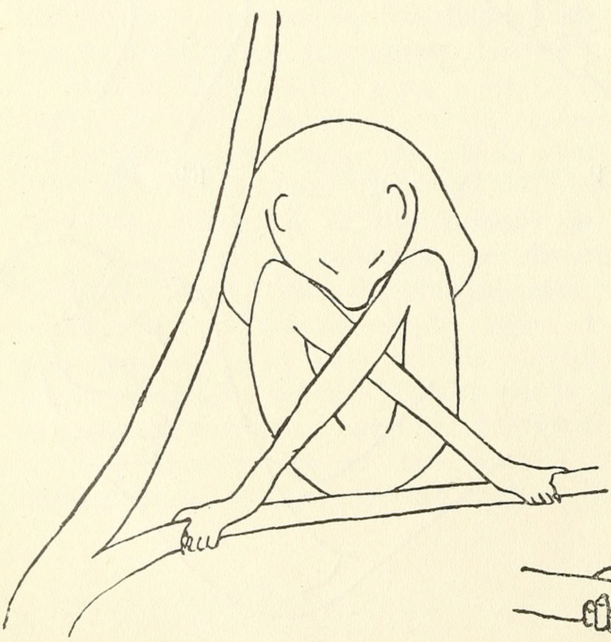

Fig. 18

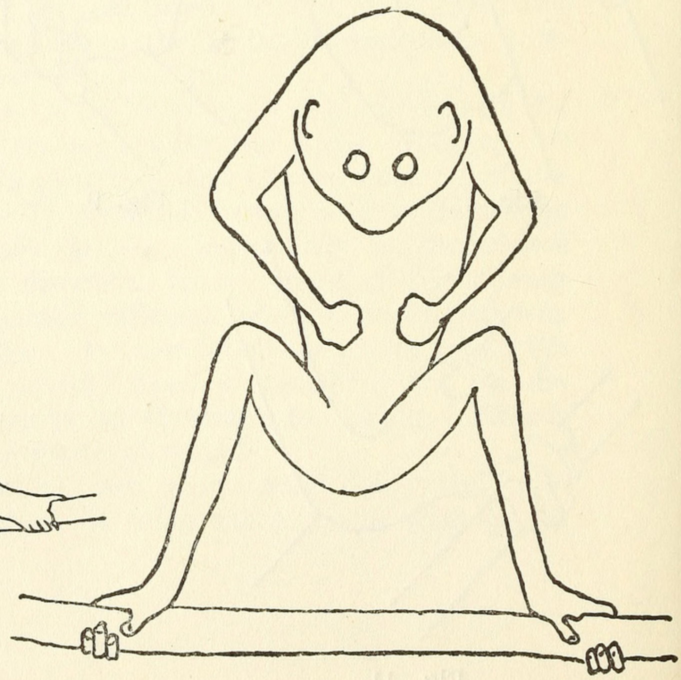

Fig. 19

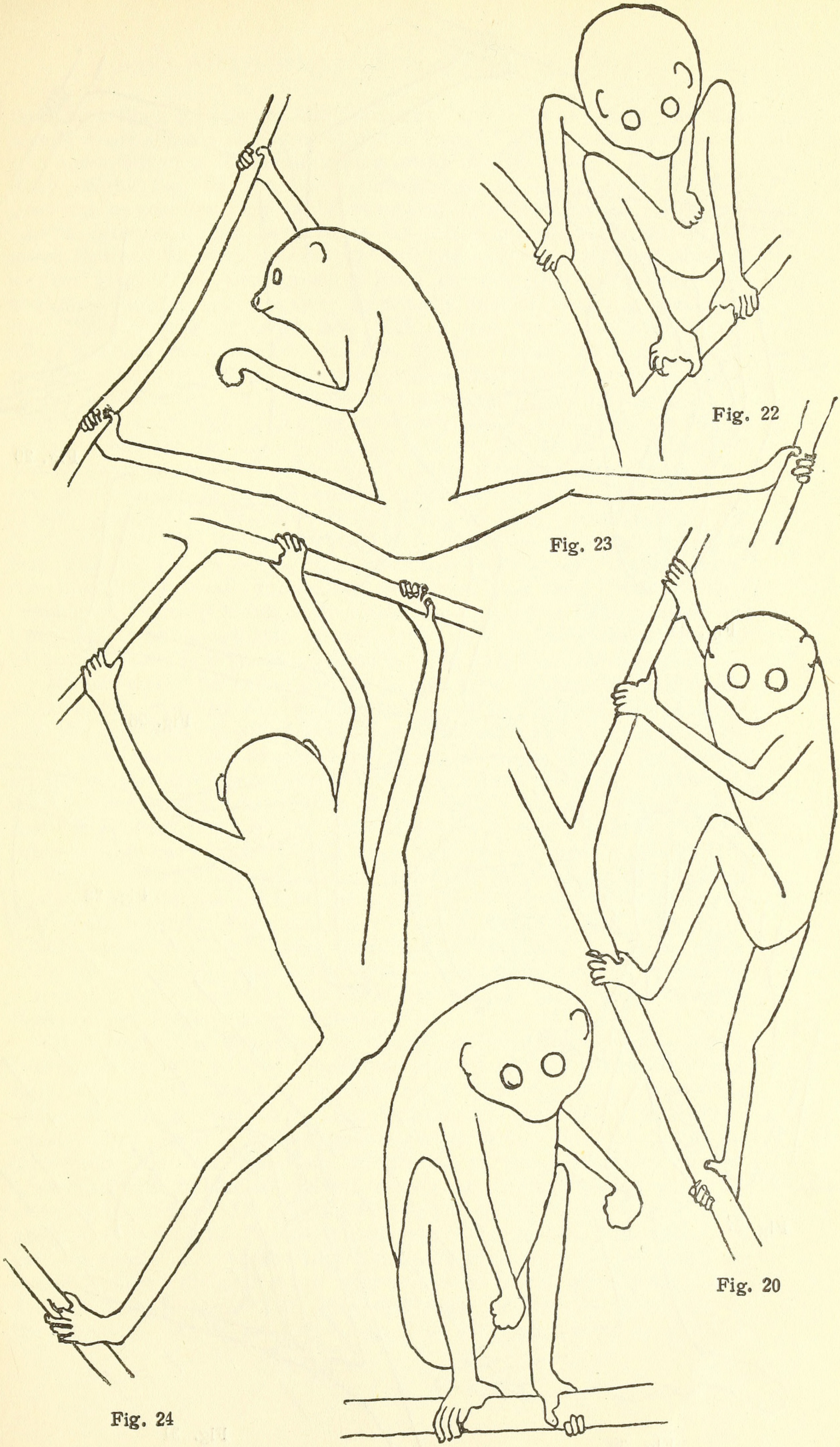

Fig. 22

Fig. 23

Fig. 20

Fig. 24

Fig. 21

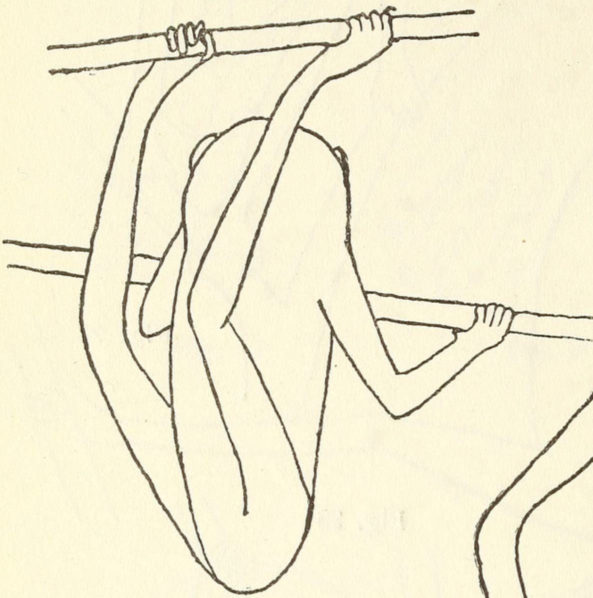

Fig. 25

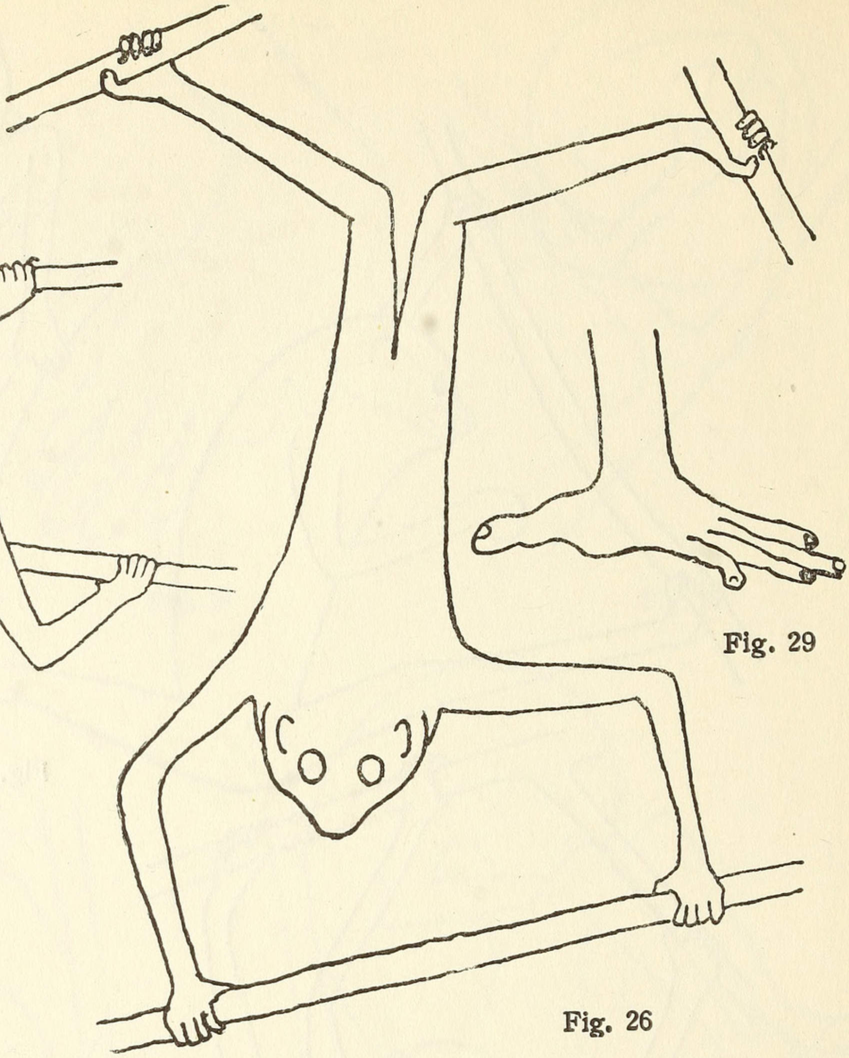

Fig. 26

Fig. 29

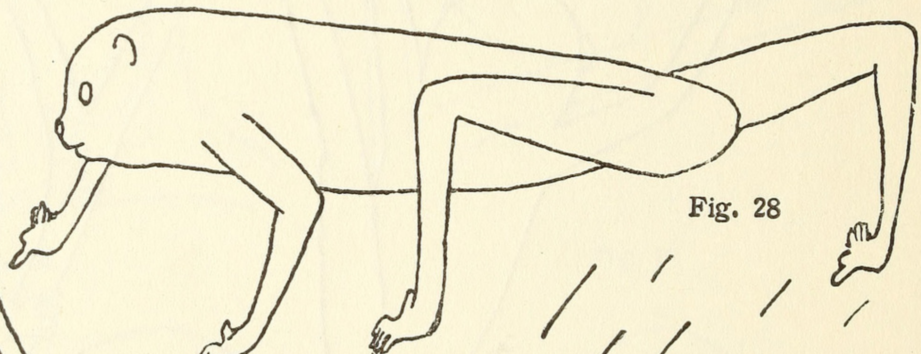

Fig. 28

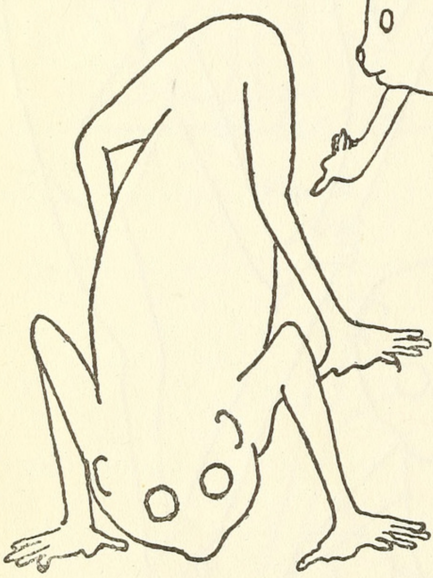

Fig. 27

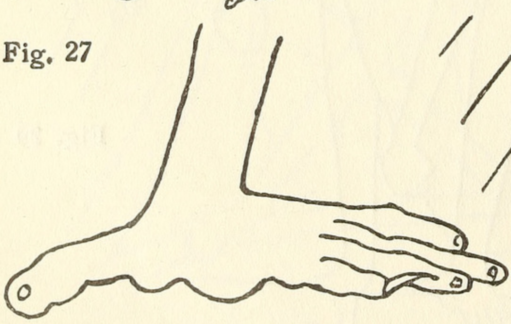

Fig. 30

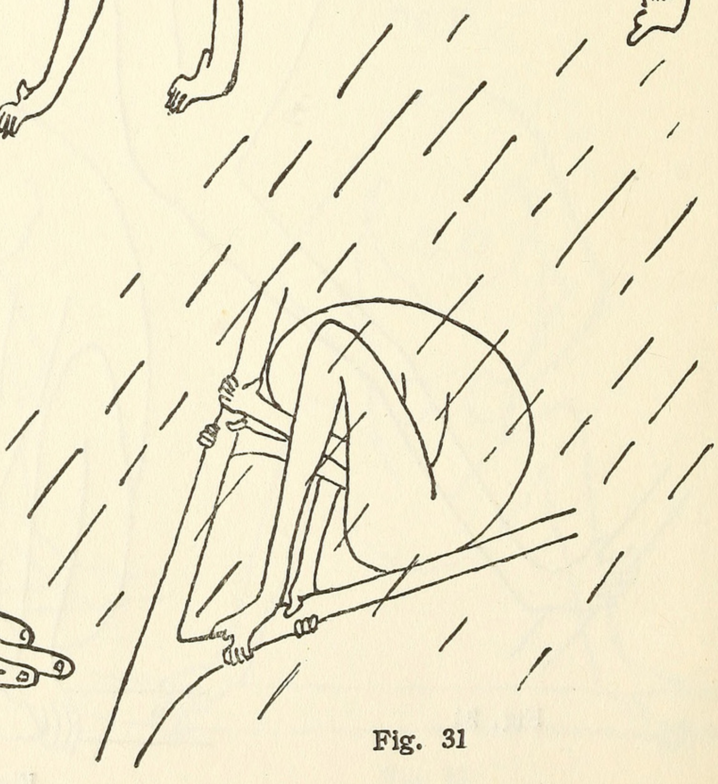

Fig. 31

hindlimbs than on that of the forelimbs, and I have found that the former are far more tenacious than the latter. While moving forward the limbs advance in the following order: right hand, left leg, left hand, right leg, in the same manner as an experienced climber goes up a coco-nut tree in Travancore. Its deliberately slow and careful movement can be seen to be the result of its hesitation to move forward its hand unless and until the advancing leg has secured a firm grip. This instinctive reliance on the grip necessitates its circumspection to select a twig sufficiently slender to get a firm grip on. Since a twig of more than half an inch in diameter does not allow its toes to completely encircle it, the animal looks round and prefers such supports in its surroundings that could enable its legs to get a firm grip. It has also been observed that, if it suspects a twig over which its leg has been placed to be a dry one or likely to break off, the leg is immediately removed and seeks after another suitable support. While climbing up, the forelimb serves to steady the position, and it is the hindlimb that pulls up the whole body. (Plate, photo I.) While climbing down, head downwards, the hindleg slowly lets down the body and, until the other leg secures a firm grip in a forward position, the rear leg is not removed from the branch. It was interesting to notice that the hindlimbs are capable of rotating a full wide circle about the hip joint, permitting their use at all imaginable angles (figs. 23-26). The forelimbs seem to have certain limitations to such a wide range of movements.

Its movement on a flat surface is also slow, deliberate, and seems to be handicapped by the peculiar position of the digitals of the hand and the leg (figs. 27-28). Being specially adapted for grasping, the pollex and hallux are placed opposite to the other digits and widely separated from the respective second digits. While walking, the thumb of the hand makes a very wide obtuse angle with the other fingers, and the base of the angle is anterior to the fore-arm (fig. 29). The same is the case with the leg (fig. 30). With such a disposition of fingers and toes, a forward movement as a result of the digitals pushing back the ground under it is difficult or not effected in a manner that could be done when the digitals are extended to the front as in Anthropoidae and Homindae. Left on the ground, the loris walks with an uneasy gait but faster than it can climb up the branch of a tree. It is evident that the limbs are adapted more for prehension than for locomotion on the ground.

To observe the animal more closely in its arboreal environment, I selected at first a short spreading mango sapling about four feet high, and left the lorises free near the foot of the stem which was about an inch in diameter. They immediately proceeded towards the small trunk, climbed it, and quickly passed on to the tiny branches. Suspecting that this tendency to go up to the extremities of the branches might be due to the lack of a larger surface area in which to move, I transferred the animals to a small spreading cashew-nut tree about ten feet high. I still noticed the same tendency of going up and up to the end of the tiny branches; here they settled down to double up ventrally and go to sleep. It was ten in the morning, and I could not see any further movements on the tree as they slept in the day-time. Early next morning, just after 5-30 a.m., I repeated the previous day's experiment by letting loose the lorises on the same cashew-nut tree. They behaved as they did before, and went out to the extremities of the branches. One of them walked along a thick branch going sideways, avoiding the one standing vertically. It did not attempt to climb up this branch which was more than an inch in diameter. It continued along the horizontal branch till it came to another vertical offshoot about half an inch in diameter, which it climbed. I was led to suspect that the animal was either unable or felt it difficult to climb up any limb of the tree which was too thick for its feet to grip, and that was perhaps why it always went out sideways in search of a slenderer branch. To test this I took out the lorises from the tree and let them loose at the foot of another cashew-nut tree, whose trunk was about four inches in diameter and with no branches within three feet of the ground. The trunk was smooth without any notches or cracks. The lorises attempted to climb it but they failed. They could not get a grip on the smooth surface of such a thick stem, even with the help of the sharp claws on the second digits of the hands and feet.

I transferred the animals to the foot of a large portia tree, whose bark was cracked into deep crevices and rough projections. The lorises succeeded with evident difficulty in grasping the broken bark and climbed up the tree. This shows that the animals have to rely entirely on the grip of their feet and hands for arboreal locomotion.

In all my observations of its movements on the trees I did not notice a single instance when it could jump or swing out from one branch to another. I have noticed the animal hanging from a branch by its feet in order to reach another support below, but have never seen its hanging by its forelimbs. To test its capacity to jump from one branch to another I conducted the following experiment.

I let loose a loris on a slender branch of a solitary cashew-nut tree. It moved slowly along and, when it reached the extremity of the branch, I bent down the branch so that the twigs and leaves were about two feet away from the adjoining twigs. The loris moved about on the branch in order to come to a position close enough to be able to reach out to one of the twigs farther away. Finding none available, it stood on its legs and tried to reach up. Failing again, it settled down and sat quiet. If it could jump it would have certainly done so.

It was rather difficult to observe their movements at night. A two hour watch by shifts was arranged one night to observe them. The animals were awake throughout the night, and were constantly moving about inside the cage showing unmistakable signs of impatience.

A marked difference was observed in the way the loris grasps a horizontal support by its feet, characteristically different from what a member of the Anthropoidae does. An anthropoid leg grasps a horizontal branch in front with the plantar surface away from it. The loris is seen to grasp it with the plantar surface towards it. In the case of a vertical or nearly vertical branch there seems to be no difference in the method of the grasp in the loris and the anthropoid.

At the beginning of the study under report, the lorises were kept for a few days in spacious cages with wire-netting fronts with